



Reversible Antibody Trap for Selective Sensor Devices

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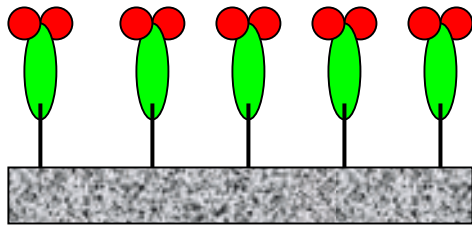
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Reversible Antibody Trapping For Selective Sensor Devices

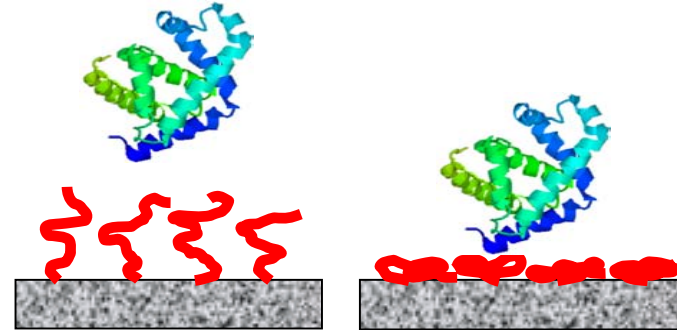
Tethered Antibodies



selective, but static

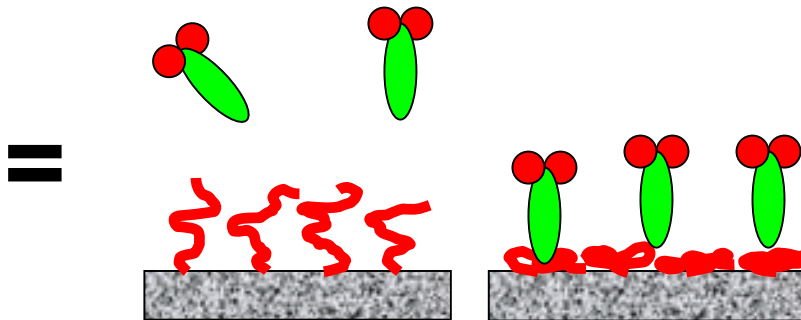
+

Switchable PNIPAM Film



programmable, but non-selective

Combined Antibody Trap

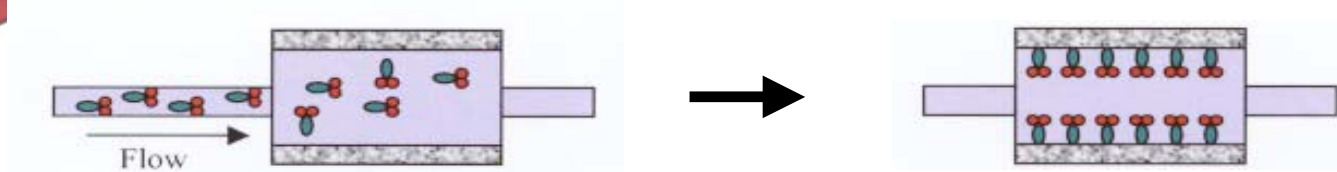


programmable and selective

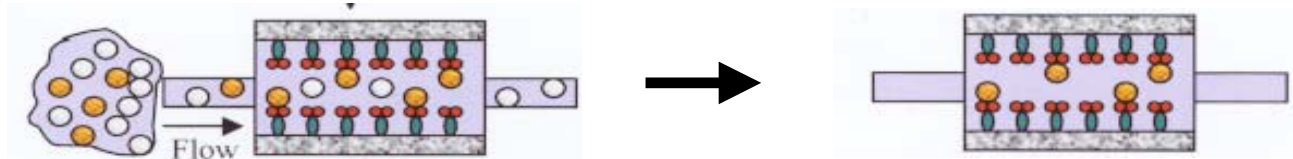
New Laboratory Directed Research and Development Project for FY'04:

- ***Develop Programmable, Selective Biomaterial Interfaces.***
- ***Integrate Bio-Active Materials into Sensors for Homeland Defense***

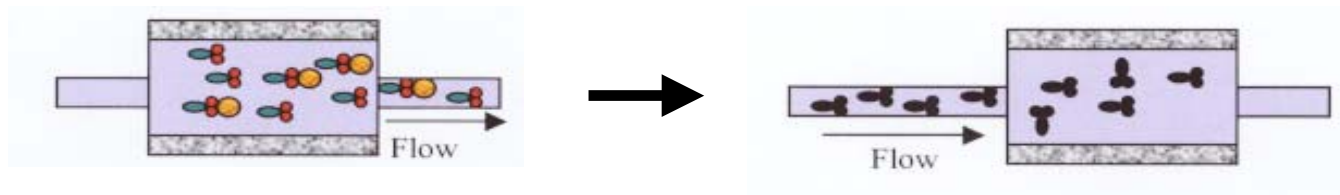
Selective Surfaces via Antibody Trapping



PNIPAM grabs antibodies to create highly selective protein monolayer.



Antibody layer captures bioactive agents.



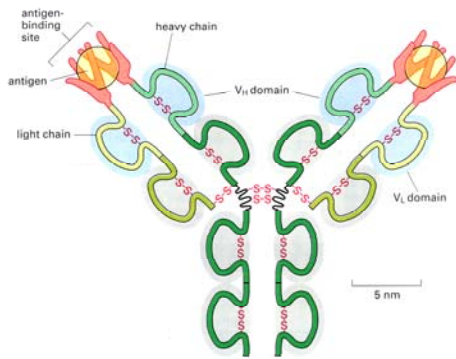
PNIPAM releases active agents, resets to adsorb new proteins.

Materials Issues: Interactions of Proteins with Bioactive Surfaces

- 1) Reversibility of species adsorption/desorption.
- 2) Activity of antibodies in adsorbed films (packing, orientation).
- 3) Competition for active surface sites in complex biofluids.

Program Components

Antibody Interactions



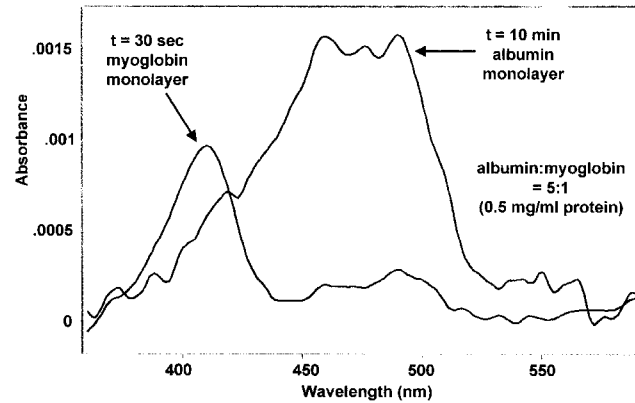
Active Films

Dale Huber

Antibodies/Antigens

George Bachand

Characterization



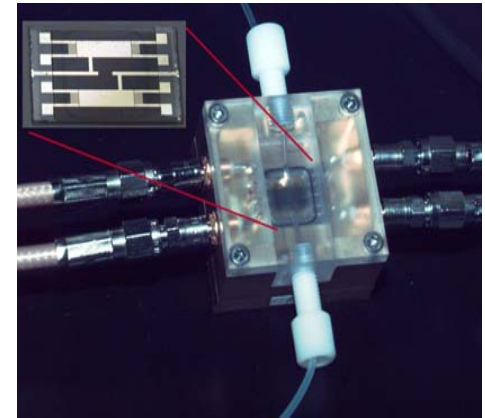
Surface Spectroscopy

Interfacial Force Microscopy

Bruce Bunker

Neutron Reflectivity (LANSCE)

Integrated Sensors



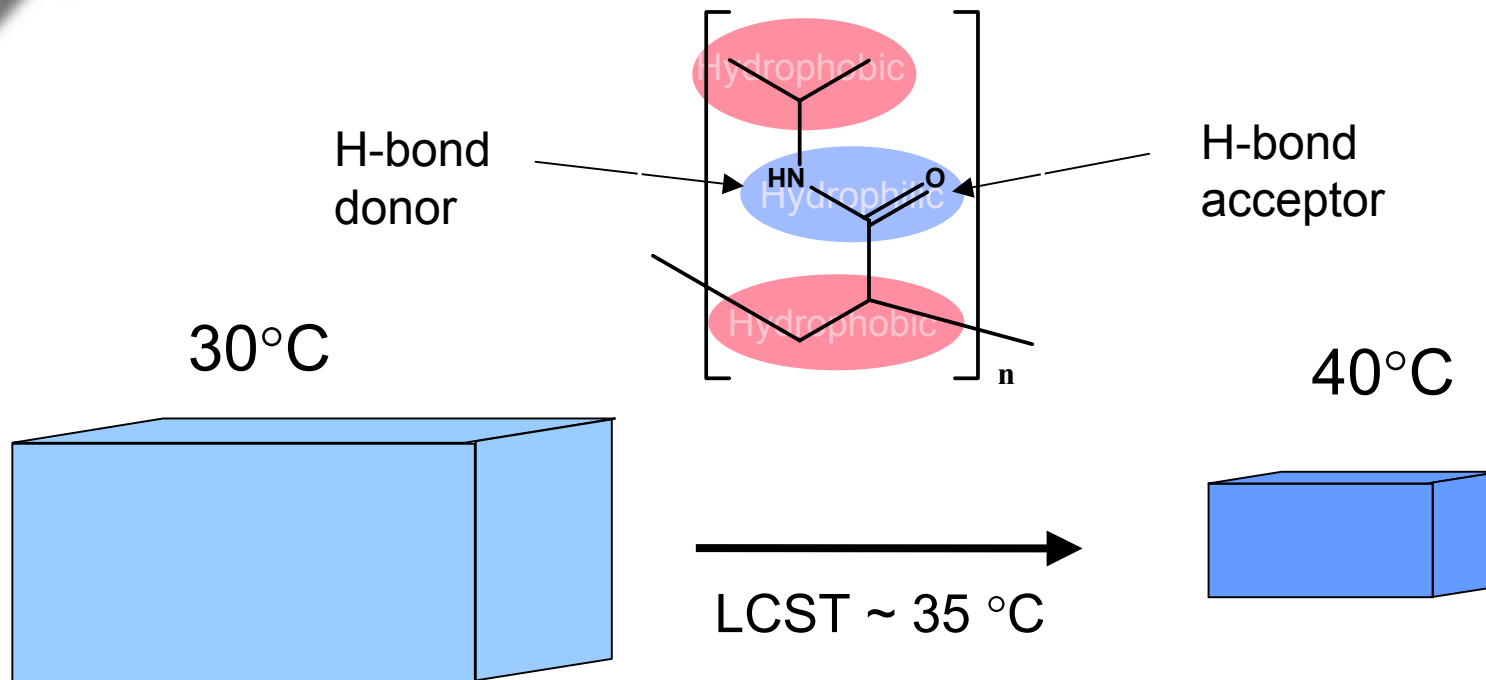
Thermal Switching

Ron Manginell

SH-SAW Sensors

Susan Brozik

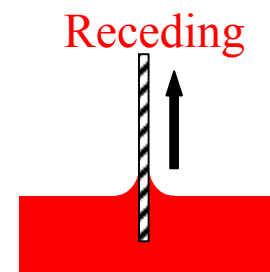
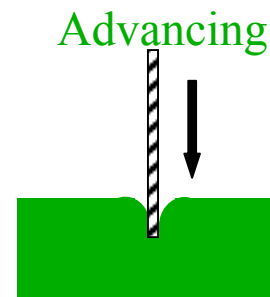
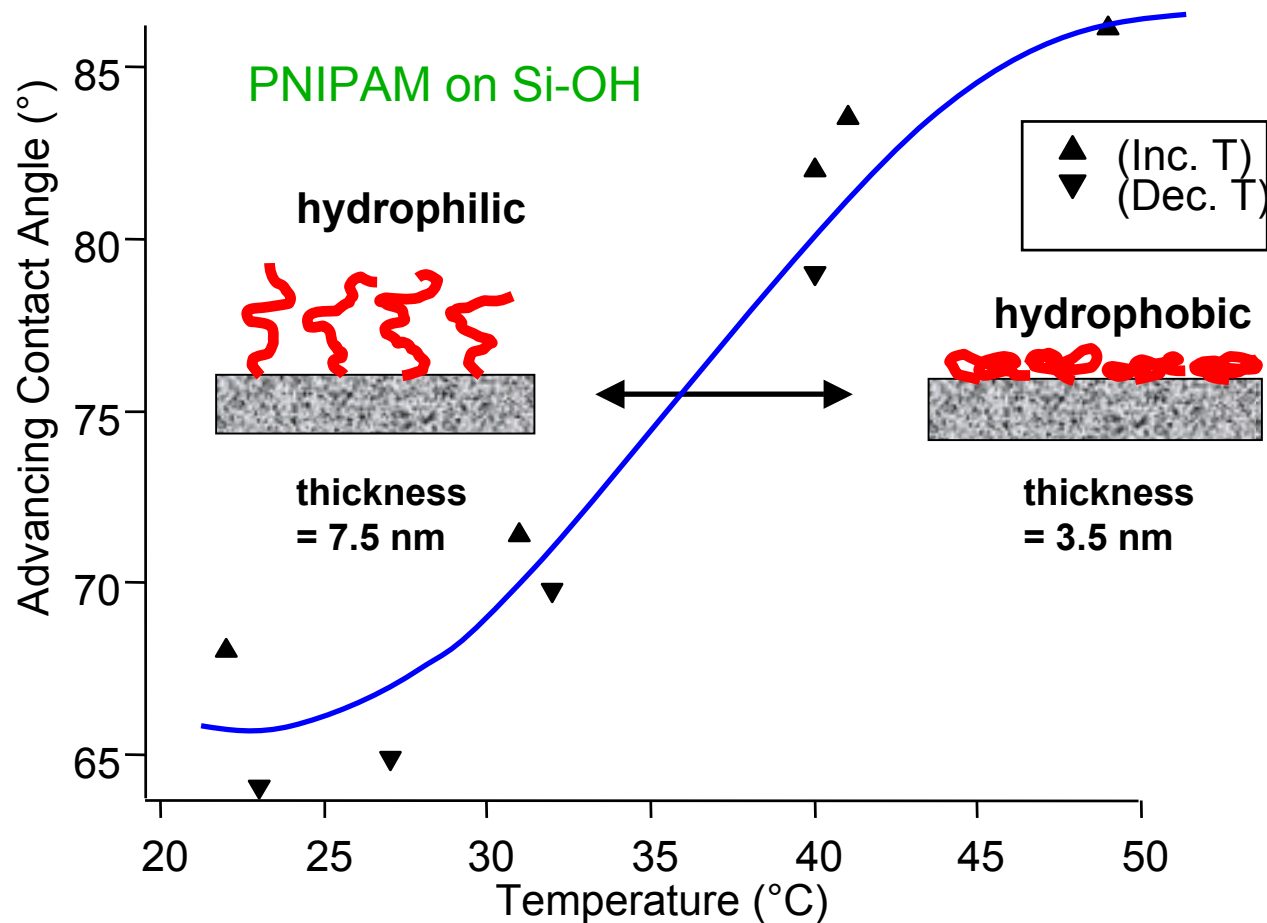
Properties of Poly(NIPAM) Gels



- Swollen with water--heavily hydrogen bonded
- Hydrophilic surface
- Resists protein adsorption

- Hydrogen bonding disrupted--deswelled
- More hydrophobic surface
- Does not resist protein adsorption

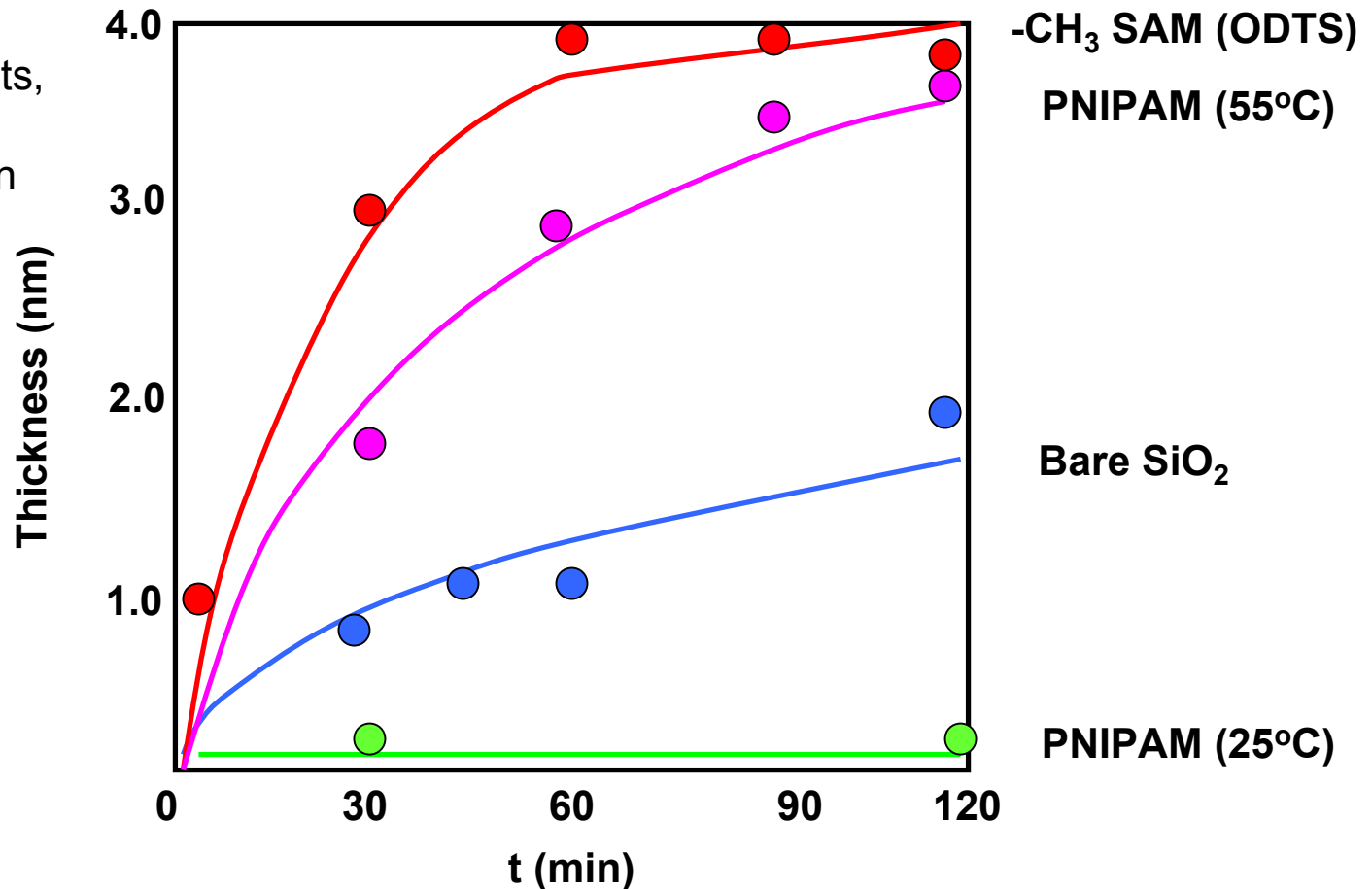
Variable Temperature Contact Angle Measurements Show Reversible Switching in Tethered PNIPAM Films



- Receding contact angle constant at 40°C

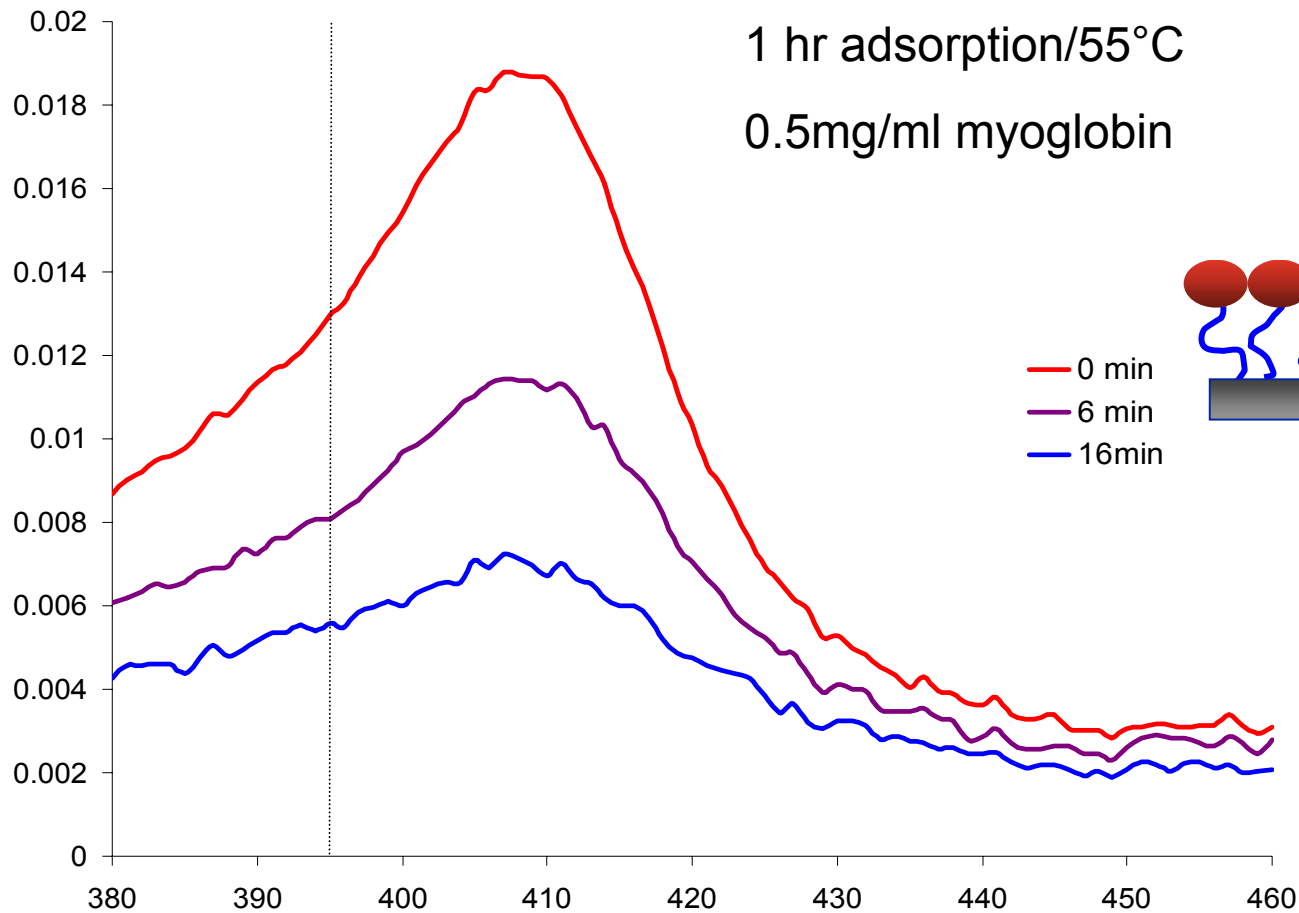
Trend: Hydrophobic Surfaces Adsorb Proteins Hydrophilic Surfaces Don't

Ellipsometry Results,
Human Serum
Albumin Adsorption

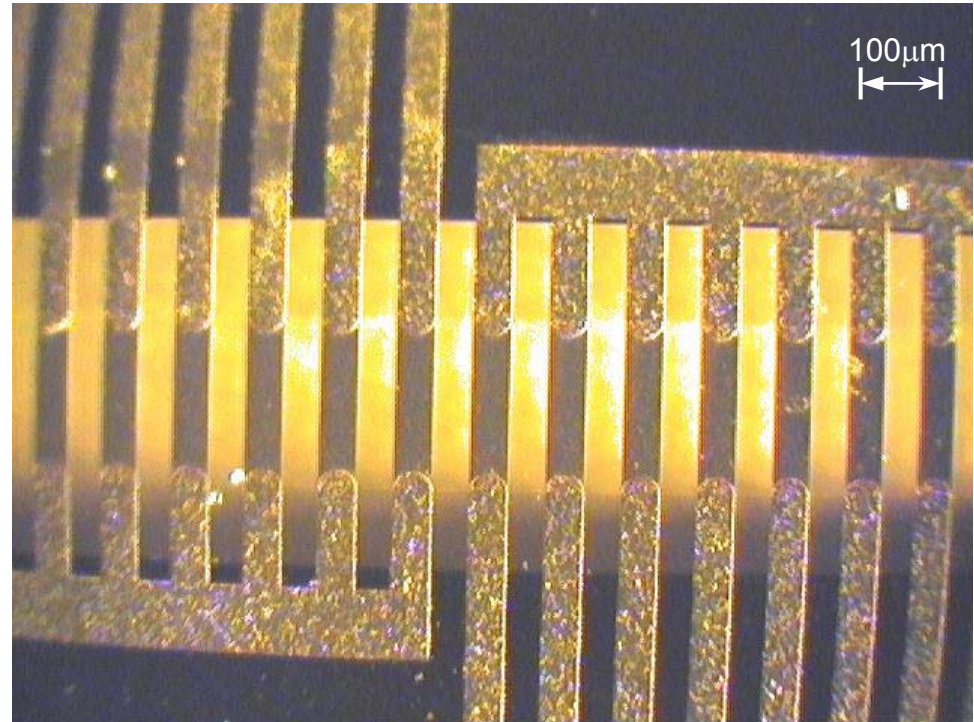
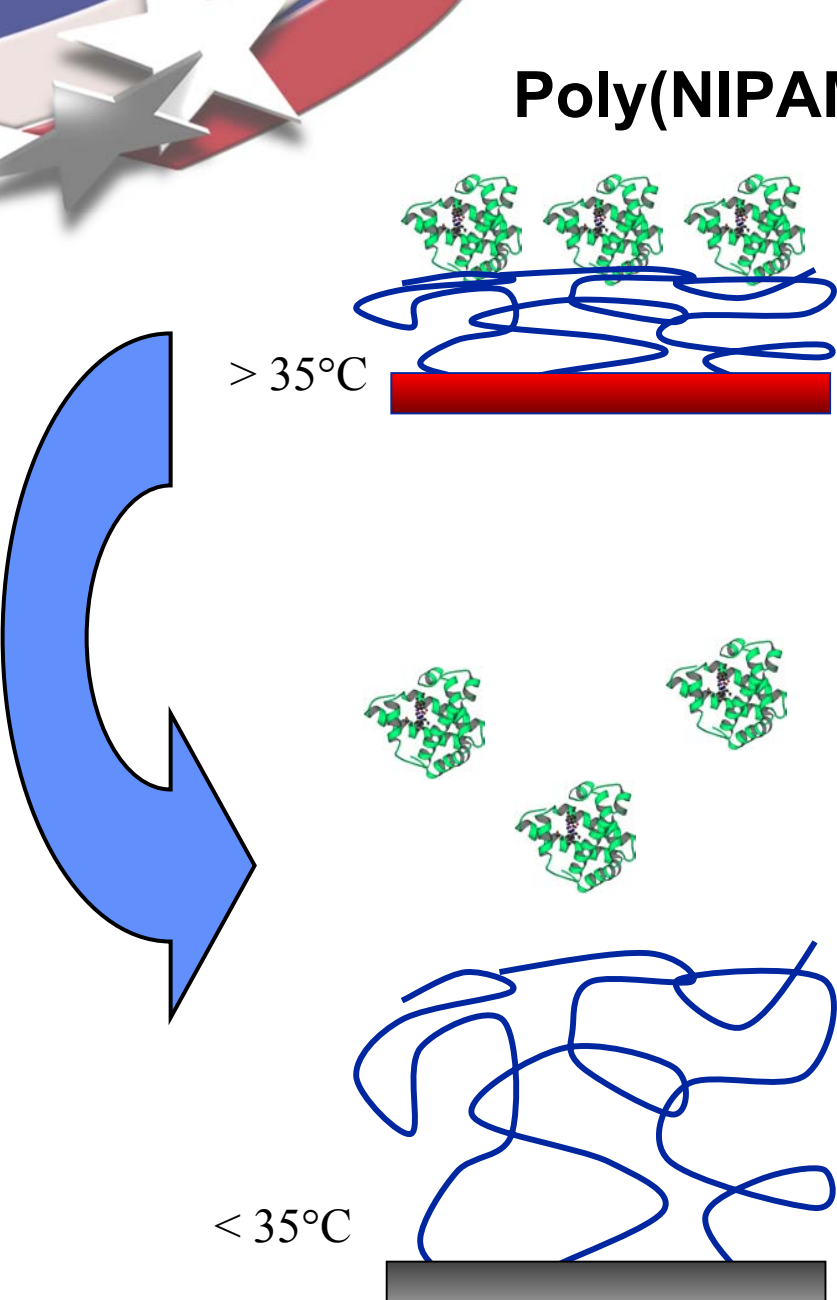


PNIPAM resists protein adsorption at 25°C.
Adsorption is extensive on PNIPAM at 55°C.

Native Myoglobin Desorbs When PNIPAM Switches



Poly(NIPAM) Functionalized Microchip



Programmed adsorption and release of proteins in a microfluidic device

Huber, Manginell, Samara, Kim, and Bunker

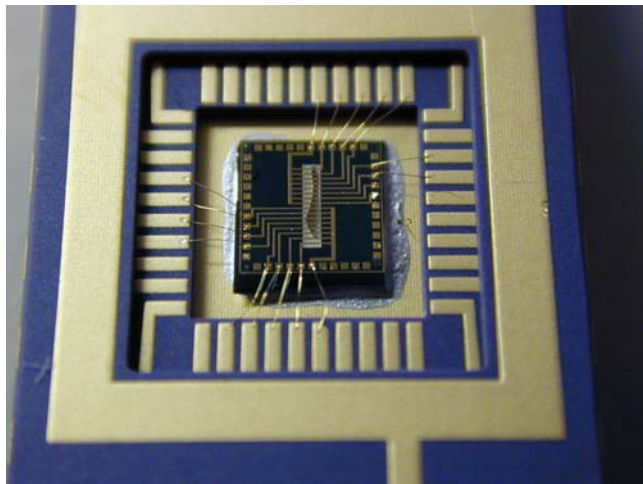
Science **301**, no.5631, p.352-354





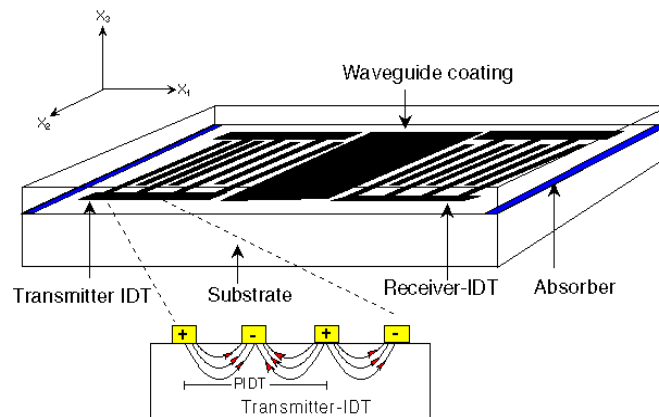
Integrated Sensor Devices

Thermally-Activated Protein Trap



Shear-Horizontal Surface Acoustic Wave (SH-SAW) Sensor

+



Rapid Switching:
Adsorption/desorption of
protein monolayers in < 1 sec.

Exceptional Mass Sensitivity:
500 pg/cm² (0.15% IgG monolayer)
(800 spores/ml detected)

Materials Issues: Integration of thermal and acoustic properties.

- 1) Acoustic Issues - PNIPAM on waveguiding, acoustics on phase transition
- 2) Thermal Issues - LiTaO₃ behavior vs. T , thermal response times



Preliminary Results

- Achieved total reversibility of protein adsorption on pNIPAM films.
- Can capture protein from very dilute solutions.
- Adsorption behavior of antibodies on pNIPAM is similar to other proteins, except there is a tendency to form multilayers.
- Antibody adsorption is reversible.
- Currently quantifying binding activity as a function of surface coating for a series of antibodies (native and engineered).
- Designs for integration of heating, SAW devices are being developed.

Conclusions

- **Developing a small, reusable, highly selective sensor**
- **Can be programmed for just one antigen or a series of antigens by using a sensor array.**
- **May be programmed on the spot for any antigens for which antibodies are available**
- **After use, the spent antibodies can be flushed, and the same or different antibodies can be adsorbed.**
- **Can be integrated into existing Sandia Micro-chemlab platform.**

